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Hsu et al.

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(54) **LID FOR MICRO-ELECTRO-MECHANICAL DEVICE AND METHOD FOR FABRICATING THE SAME**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
H01L 23/28 (2006.01)

(52) **U.S. Cl.**
USPC **174/522**; 381/355; 174/265; 174/255; 174/262; 257/704

(58) **Field of Classification Search**
USPC 174/50, 250–268, 522, 524, 521; 257/704; 381/355, 361, 360
See application file for complete search history.

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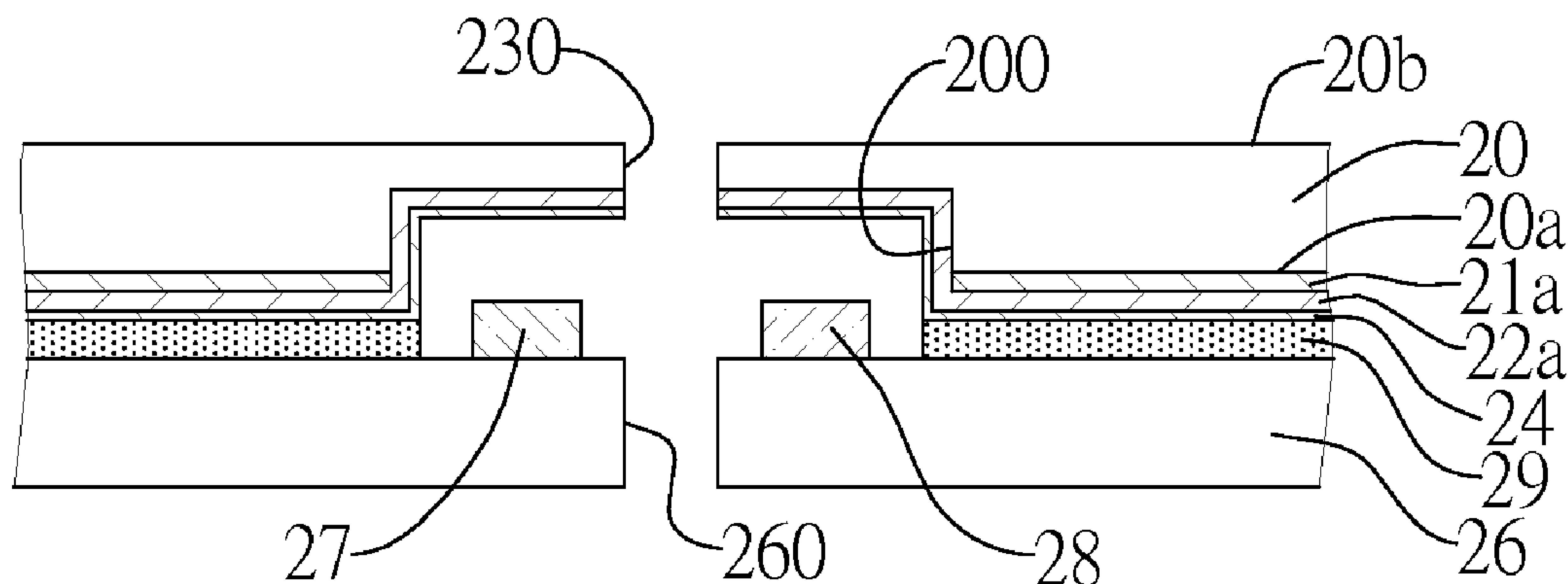
(57) **ABSTRACT**

A lid for a micro-electro-mechanical device and a method for fabricating the same are provided. The lid includes a board with opposite first and second surfaces and a first conductor layer. The first surface has a first metal layer thereon. The first metal layer and the board have a recess formed therein. The recess has a bottom surface and a side surface adjacent thereto. The first conductor layer is formed on the first metal layer and the bottom and side surfaces of the recess. The shielding effect of the side surface of the board is enhanced because of the recess integral to the board, the homogeneous bottom and side surfaces of the recess, and the first conductor layer covering the first metal layer, the bottom and side surfaces of the recess.

3 Claims, 3 Drawing Sheets



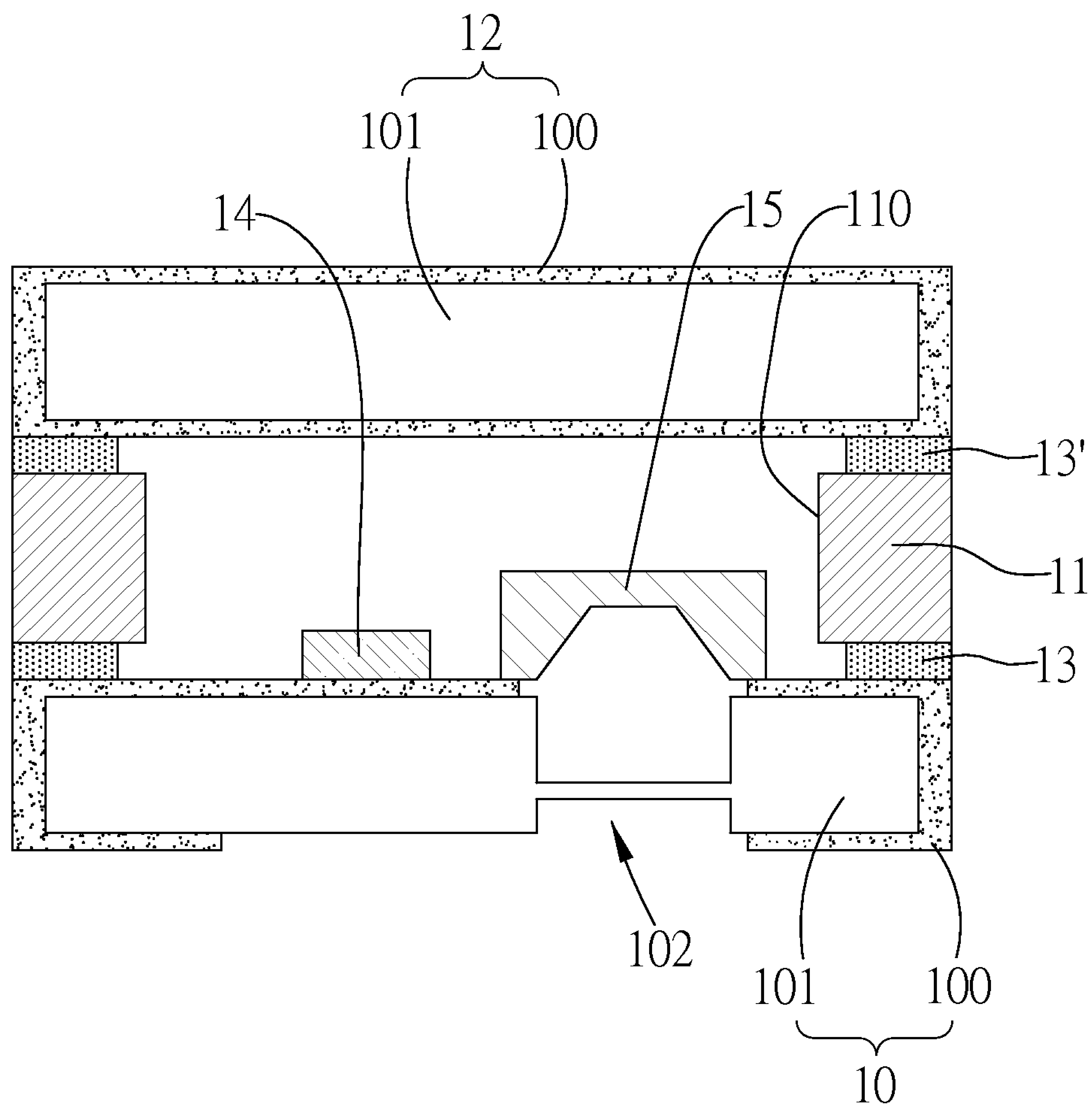


FIG. 1(PRIOR ART)

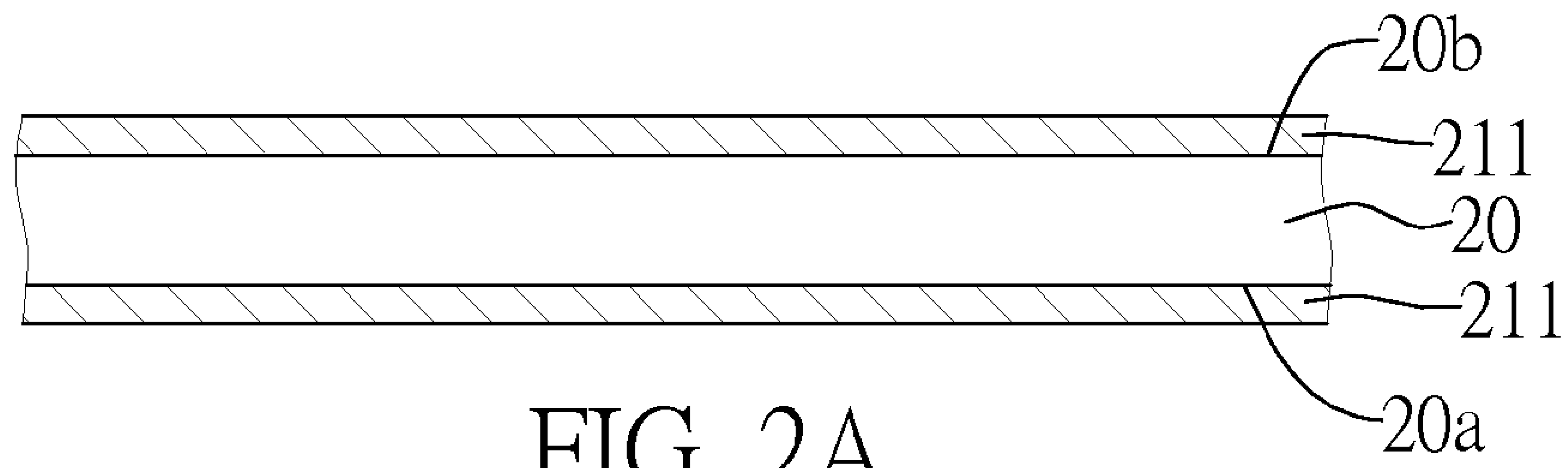


FIG. 2A

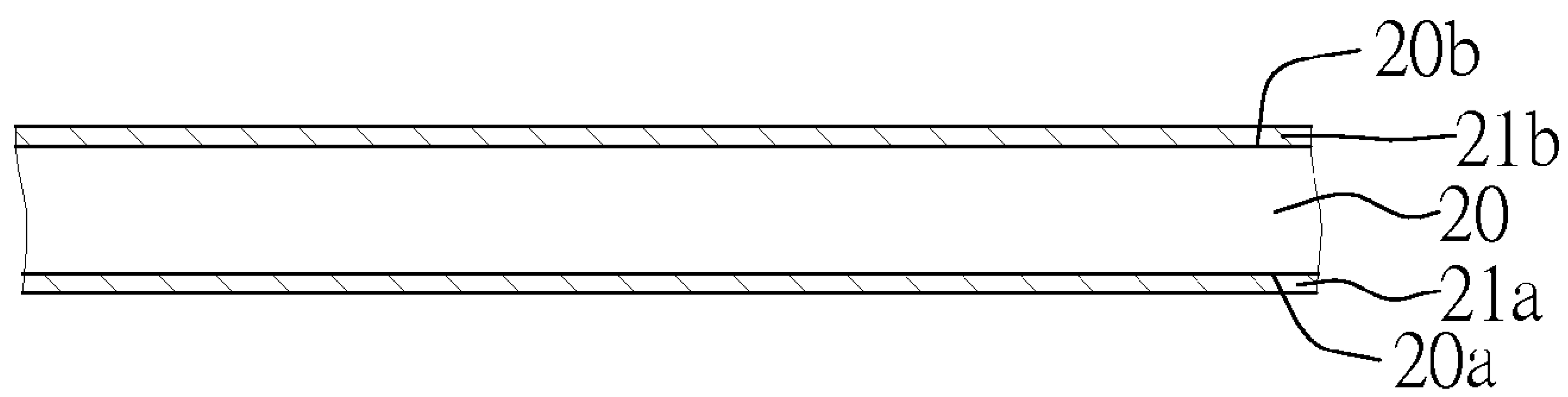


FIG. 2B

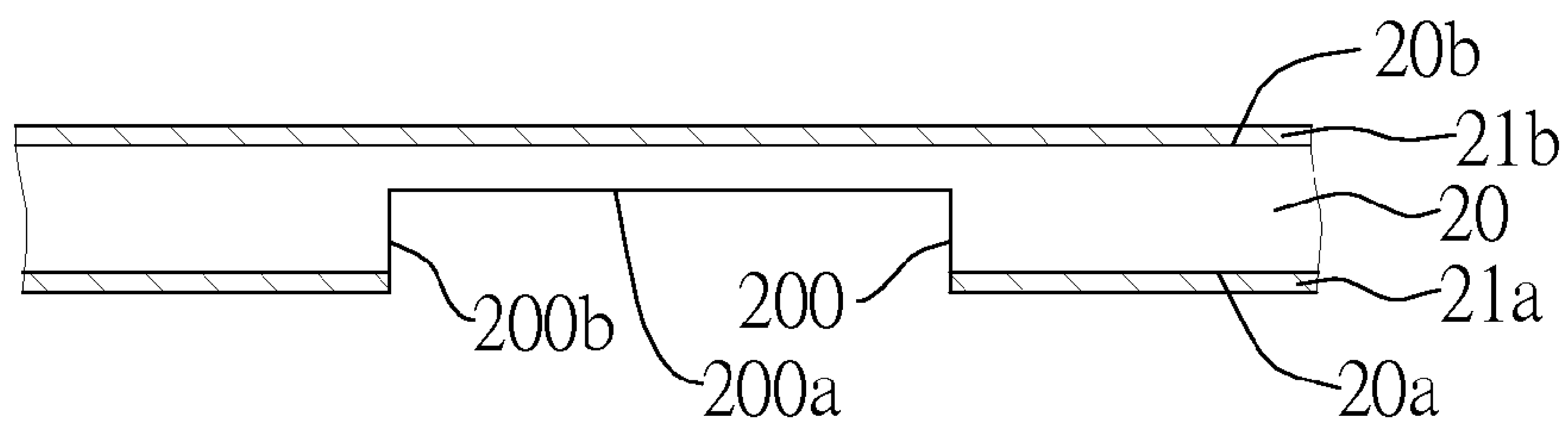


FIG. 2C

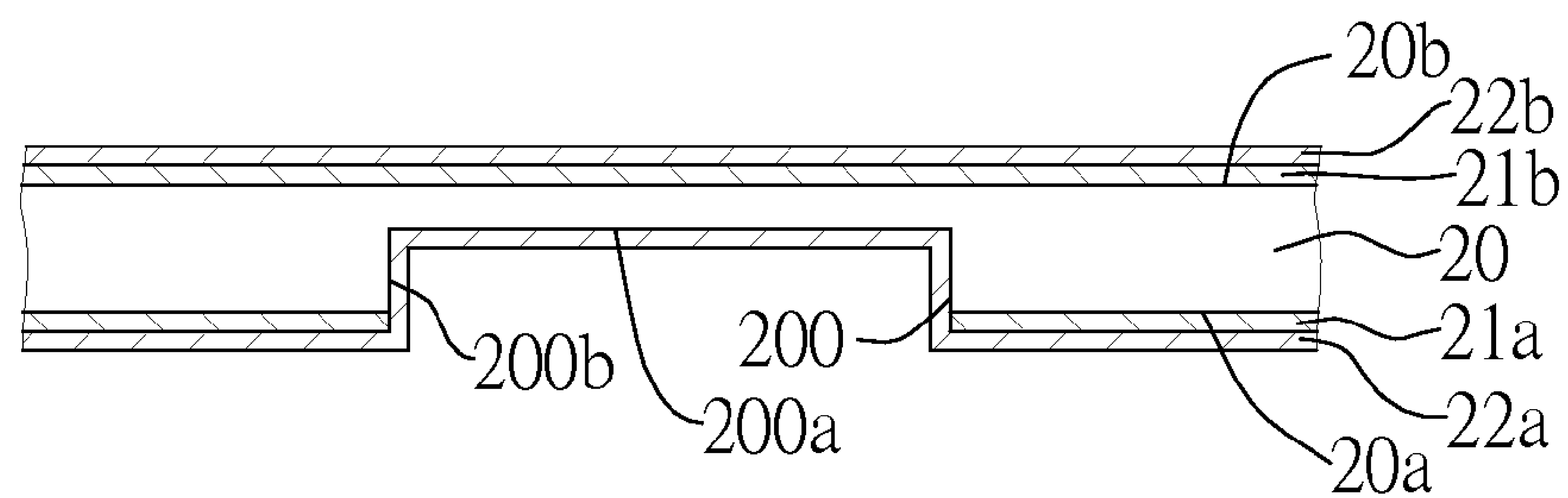


FIG. 2D

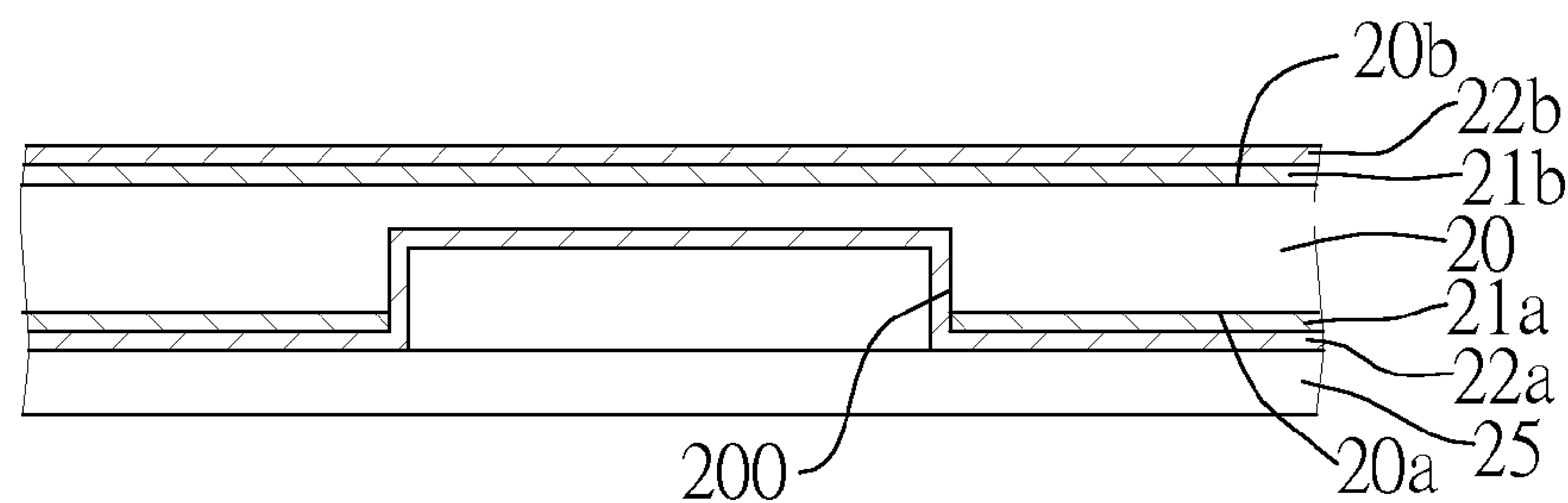


FIG. 2E

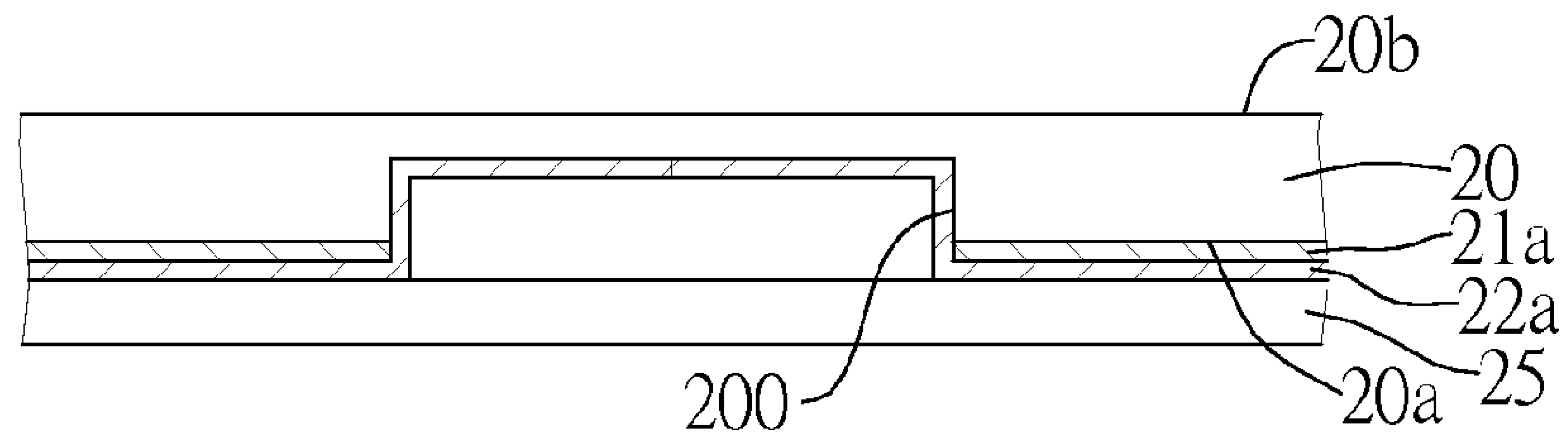


FIG. 2F

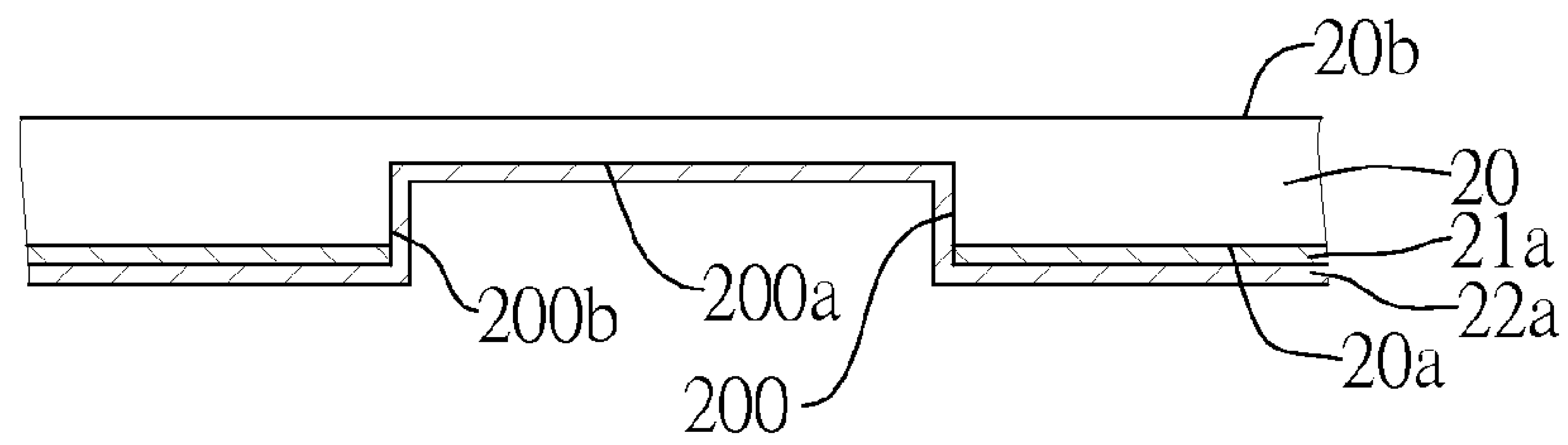


FIG. 2G

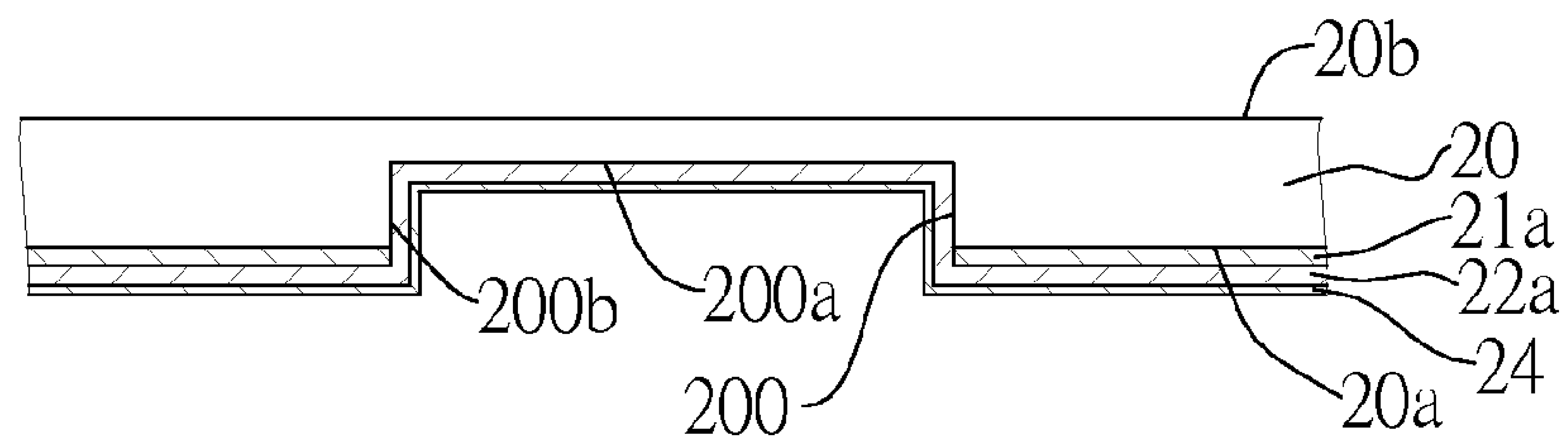


FIG. 2H

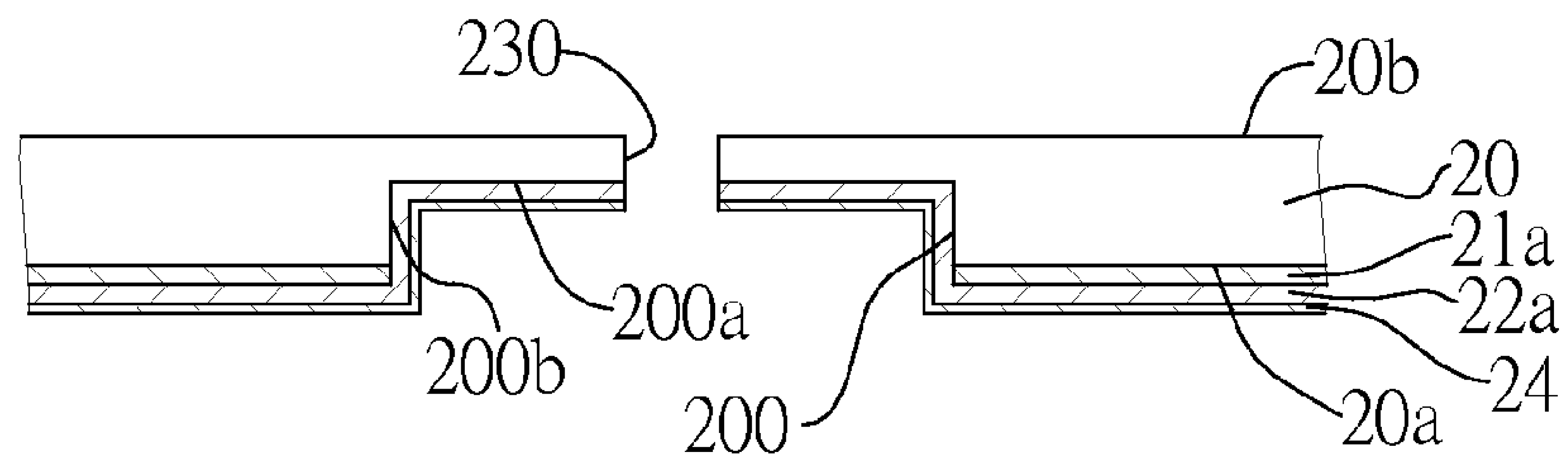


FIG. 2I

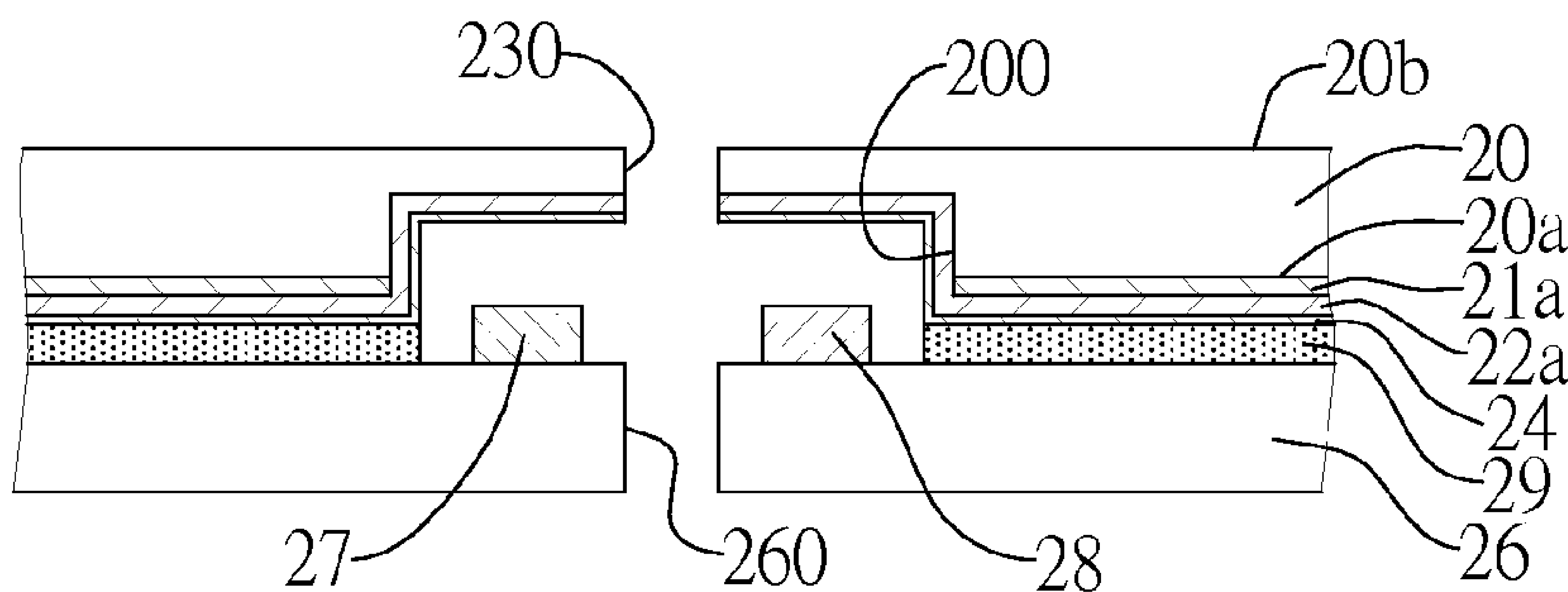


FIG. 2J

LID FOR MICRO-ELECTRO-MECHANICAL DEVICE AND METHOD FOR FABRICATING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to lids, and more particularly, to a lid for use in a micro-electro-mechanical device to have an enhanced shielding effect upon the micro-electro-mechanical device and a method for fabricating the same.

2. Description of the Prior Art

Micro-electro-mechanical devices, such as microphones, are in wide use in mobile communication devices, audio devices, etc. To achieve miniaturization, microphones for use as hearing aid units, typically known as condenser microphones, are downsized. However the transducers therein are fragile and susceptible to physical damage. Furthermore, since signal transmission is subject to be interfered with by the environment, the transducer must be protected from light and electromagnetic interferences. Moreover, favorable acoustic pressure is required for the transducer to function properly, as far as prevention of light and electromagnetic interference is concerned. Please refer to FIG. **1** for condenser microphones in wide use.

Referring to FIG. **1**, a conventional condenser microphone comprises: a first substrate **10**, a conductive plate **11** coupled to the first substrate **10** by means of a conductive adhesive layer **13**, and a second substrate **12** coupled to the conductive plate **11** by means of another conductive adhesive layer **13'**. The first substrate **10** comprises a mold plate **100** and a backboard **101**, and so does the second substrate **12**. An auditory aperture **102** is formed in the first substrate **10**. A semiconductor chip **14** is mounted on the first substrate **10**. Also, a transducer **15** above the auditory aperture **102** is mounted on the first substrate **10**. A through cavity **110** formed in the conductive plate **11** not only provides room for different acoustic pressures but also receives the semiconductor chip **14** and the transducer **15**.

The conventional condenser microphone provides a protective space defined by the first substrate **10**, the through cavity **110** of the conductive plate **11**, and the second substrate **12**, so as to insulate the semiconductor chip **14** and the transducer **15** and achieve the shielding effect. However, the conductive adhesive layer **13** and the conductive plate **11** differ from each other in constituents, thus deteriorating the shielding effect of the side surface of the condenser microphone.

Accordingly, an issue that calls for immediate solution involves endeavors to overcome the aforesaid drawbacks of the prior art.

SUMMARY OF THE INVENTION

In light of the aforesaid drawbacks of the prior art, it is a primary objective of the present invention to provide a lid for use in a micro-electro-mechanical device and a method for fabricating the same with a view to boosting the shielding effect upon the micro-electro-mechanical device.

To achieve the above and other objectives, the present invention discloses a lid for use in a micro-electro-mechanical device. The lid comprises: a board with opposite first and second surfaces, the first surface having a first metal layer disposed thereon, wherein the first metal layer and the board have a recess therein to penetrate the first metal layer and extend into the board, and the recess has a bottom surface and a side surface adjacent thereto; and a first conductor layer disposed on the first metal layer and the bottom surface and the side surface of the recess.

The lid further has a hole which spans from the second surface of the board to the bottom surface of the recess and penetrates the first conductor layer. A surface treatment layer made of nickel, palladium, gold, tin, or a combination thereof is disposed on the first conductor layer.

The present invention further discloses a method for fabricating a lid for a micro-electro-mechanical device, comprising the steps of: providing a board with a first surface having an initial metal layer thereon and an opposite second surface; roughening the initial metal layer such that the initial metal layer forms a first metal layer; forming a recess to penetrate the first metal layer, cross the first surface, and extend into the board such that the recess thus formed has a bottom surface and a side surface adjacent thereto; forming a first conductor layer on the first metal layer and the bottom surface and the side surface of the recess, and forming a second conductor layer on the second surface of the board; forming a resist layer on the first conductor layer; removing the second conductor layer; and removing the resist layer.

Alternatively, the second surface of the board also has an initial metal layer thereon, and thus a second metal layer is formed as well as the first metal layer by roughening, and the second metal layer is subsequently removed as well as the second conductor layer.

The method further comprises roughening and thinning the initial metal layer by an etching process.

The method further comprises forming a hole to span from the second surface of the board to the bottom surface of the recess and penetrate the first conductor layer. Also, the method further comprises forming on the first conductor layer a surface treatment layer made of nickel, palladium, gold, tin, or a combination thereof.

Unlike its conventional counterpart, the bottom surface and the side surface of the recess are integrally formed in the board of the present invention, and a first conductor layer is disposed to coat the bottom surface and the side surface of the recess. Hence, the shielding effect upon the micro-electro-mechanical device of the present invention is enhanced.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** (PRIOR ART) is a cross-sectional view of a conventional condenser microphone; and

FIGS. **2**A through **2**J are cross-sectional views of a method for fabricating a lid of a micro-electro-mechanical device of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The present invention is herein illustrated with specific embodiments, so that one skilled in the pertinent art can easily understand other advantages and effects of the present invention from the disclosure of the invention.

FIGS. **2**A through **2**J are cross-sectional views of a method for fabricating a lid of a micro-electro-mechanical device of the present invention. Referring to FIG. **2**A, a board **20** with opposite first and second surfaces **20***a*, **20***b* is provided. The board **20** is made of polymer material, such as BT (Bismaleimide-triazine) core material or plastics. Two initial metal layers **211** are formed on the first and second surfaces **20***a*, **20***b*, respectively.

Referring to FIG. **2**B, the initial metal layers **211** on the first and second surfaces **20***a*, **20***b* are roughened and thinned by

an etching process, so as to form a first metal layer **21***a* from the initial metal layer **211** on the first surface **20***a* and form a second metal layer **21***b* from the initial metal layer **211** on the second surface **20***b*.

Referring to FIG. **2**C, a recess **200** is formed to penetrate the first metal layer **21***a*, cross the first surface **20***a*, and extend into the board **20**. The recess **200** has a bottom surface **200***a* and a side surface **200***b* adjacent thereto.

Referring to FIG. **2**D, a first conductor layer **22***a* is formed on the first metal layer **21***a* and the bottom surface **200***a* and the side surface **200***b* of the recess **200**, and a second conductor layer **22***b* is formed on the second metal layer **21***b*. Alternatively, a seed layer (not shown) is formed prior to the formation of the first and second conductor layers **22***a*, **22***b* which are made of metal such as copper. The seed layer functions as an electrical conduction path for electroplating and comprises metal, alloy, and a plurality of deposited metal layers.

Referring to FIGS. **2**E and **2**F, a resist layer **25** is formed above the first conductor layer **22***a* as shown in FIG. **2**E, and then the second conductor layer **22***b* together with the second metal layer **21***b* are removed as shown in FIG. **2**F.

Referring to FIGS. **2**G and **2**H, the resist layer **25** is removed as shown in FIG. **2**G, and then a surface treatment layer **24** made of nickel, palladium, gold, tin, or a combination thereof is formed on the first conductor layer **22***a* as shown in FIG. **2**H.

As disclosed in the present invention, the shielding effect of the side surface of the board **20** is enhanced, not only because the recess **200** is integrally formed in the board **20**, wherein the bottom surface **200***a* and the side surface **200***b* of the recess **200** are made of the same material, but because the inside of the recess **200** is readily covered with the same material (e.g., the first conductor layer **22***a*).

Referring to FIG. **2**I, a hole **230** is formed to span from the second surface **20***b* of the board **20** to the bottom surface **200***a* of the recess **200** and penetrate the first conductor layer **22***a* and the surface treatment layer **24**.

Referring to FIG. **2**J, in an ensuing process, the present invention is applied to a carrier board **26**, such as a circuit board, so as to form a micro-electro-mechanical device. Semiconductor components **27**, **28**, such as an MEMS chip or an ASIC chip, are mounted on the carrier board **26**. The carrier board **26** is coupled to the first conductor layer **22***a* on the first surface **20***a* of the board **20** via a conductive coupling layer **29**. The semiconductor components **27**, **28** are received in the recess **200**. A through hole **260** is optionally formed in the carrier board **26**.

The present invention further provides a lid for a micro-electro-mechanical device. The lid comprises a board **20** and a first conductor layer **22***a*. The board **20** has opposite first and second surfaces **20***a*, **20***b*. The first surface **20***a* has a first metal layer **21***a* disposed thereon. A recess **200** is formed to penetrate the first metal layer **21***a* and extend into the board **20**. The recess **200** has a bottom surface **200***a* and a side surface **200***b* adjacent thereto.

The first conductor layer **22***a* is disposed on the first metal layer **21***a* and the bottom surface **200***a* and side surface **200***b* of the recess **200**. A surface treatment layer **24** made of nickel, palladium, gold, tin, or a combination thereof is formed on the first conductor layer **22***a*. The board **20** has a hole **230** formed therein. The hole **230** spans from the second surface **20***b* of the board **20** to the bottom surface **200***b* of the recess **200** and penetrates the first conductor layer **22***a*.

The foregoing specific embodiments are intended to illustrate the features and functions of the present invention but are not intended to restrict the scope of the present invention. It is apparent to those skilled in the art that all equivalent modifications and variations made in the foregoing embodiments according to the spirit and principle in the disclosure of the present invention should fall within the scope of the appended claims.

What is claimed is:

1. A lid of a micro-electro-mechanical device, comprising:

a board with opposite first and second surfaces, the first surface having a first metal layer disposed thereon, wherein the first metal layer and the board have a recess therein to penetrate the first metal layer and extend into the board, and the recess has a bottom surface and a side surface adjacent thereto; and

a first conductor layer disposed on the first metal layer and the bottom surface and the side surface of the recess; and

a hole to span from the second surface of the board to the bottom surface of the recess and penetrate the first conductor layer.

2. The lid of claim **1**, further comprising a surface treatment layer disposed on the first conductor layer.

3. The lid of claim **2**, wherein the surface treatment layer is made of one selected from the group consisting of nickel, palladium, gold, tin, and a combination thereof.

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